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FUTURE DEVELOPMENTS IN USSR SCIENCE

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In the year 1956, the Sixth Five-Year Plan will be launched. One may expect that in this five-year plan the role played by science and by technology as influenced by science will grow to a still greater extent.

Science is penetrating deeper into the life of Soviet society, opening new possibilities as far as technological progress and improvement of the productivity of labor is concerned. It also advances the socialist economy and leads to improvements in the well-being of the people and progress of culture. However, we must be clearly aware of the fact that the undoubted advantages of the socialist system as compared with the capitalist system are not being fully utilized in the sense that the great power of science is being put to its maximum use and that we do everything that is necessary for the development of science.

The Sixth Five-Year Plan must form a turning point in this respect. The abysmal technological backwardness of prerevolutionary Russia imposed on the Soviet Union the task of overtaking the technology of advanced capitalistic countries which were far ahead of Russia as far as technical development is concerned. The indexes of the Fifth Five-Year Plan testified to the fact that new successes have been achieved by the USSR as far as this task is concerned. With regard to the rate of development in training specialists and the scope of this training, the USSR has moved to first place, with the result that alarm was created in the US and England. In such a field of modern technology as the atomic energy industry, the Geneva conference has shown that the USSR has moved to the forefront, a fact which world opinion recognizes. One may mention a number of other branches of new technology in which major advances made by the USSR cannot be disputed. At the same time, there are lags in some subdivisions of technology. For instance, the automatization of production processes has not been developed sufficiently. Our railroad transportation and water transportation are too slow.

The July 1955 Plenary Session of the Central Committee of the CPSU drew up an extensive program of technical development in the USSR. In carrying out this program we must make use of the new achievements of world science and technology by applying to actual technological problems results with which we are already familiar in a general sense from the scientific literature. In other words, contributions made by world science must be utilized under practical conditions. This way can be and must be followed in our attempts to overtake [foreign] technology in actual, practical applications. But in order to overtake foreign technology, we must produce our own results and apply them rapidly and effectively. For that reason we are faced with the necessity of increasing sharply during the Sixth Five-Year Plan our own scientific contributions and of paying increased attention to theoretical science and scientific research.

The most immediate actual task in this respect is to include to the fullest extent in scientific work the researchers at higher educational institutions, who comprise no less than 50% of all scientific workers of the USSR. This is a measure which follows immediately from the decisions of the July Plenary Session of the Central Committee, CPSU.

In striving for further technical advances, we ought to utilize wisely and efficiently scientific personnel of plant laboratories, higher educational institutions, specialized branch academies [the academies of medical sciences, agricultural sciences, ets.], scientific institutions, and finally of the institutes

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of the Academy of Sciences USSR. Good coordination between all stages of scientific work will enable us to utilize most efficiently the advanced scientific cadres for the solution of the cardinal problems of science.

In carrying out this coordination, the attention of the highest range of scientific organizations, i. e., of the Academy of Sciences USSR, the union republic academies, and the specialized branch academies, must be turned to those subdivisions of science and to those problems work on which will be capable of revolutionizing major subdivisions of the national economy just as, to give an example, the discovery of antibiotics has revolutionized medicine.

We must also concentrate on the application of natural phenomena which are already known and on technological processes which open up new fields, such as the use of oxygen in metallurgy, the treatment of metals by applying pressure, the precise casting of metals in industrial applications, the replacement of [piston] steam engines with turbines, etc.

The Academy of Sciences USSR, quite particularly at the institutes of its Department of Technical Sciences, is engaged in work on problems of this type. The Institue of Metallurgy, together with the specialized branch scientific research institutes of the Ministry of Ferrous Metallurgy of the USSR, is working on the improvement of the efficiency of blast furnaces by applying oxygen.

The Institute of Fossil Fuels has developed a new method of using coal, which makes a wide range of coals suitable for application in metallurgy. This method has made it possible to increase the production of all grades of ferrous metal by several millions of tons without increasing the plant capacity.

Revolutionizing effects in science and technology are usually produced by the discovery of new natural phenomena or new relationships which have not been known hitherto. To give a few examples, a revolution in the technology of communications was produced by the discovery of radio waves and a revolution in the synthesis of rubber as well as an entirely new trend in the textile industry have been produced by the discovery of macromolecules and methods of synthesizing them.

Practical experience shows that one must concentrate major scientific and technical efforts early enough on new scientific discoveries which are of fundamental importance and of which the significance has been recognized. Occasionally we do not apply enough persistence and consistency in carrying out scientific research until the very end. This results in harm to science and to the economy.

Every result of research which is of scientific importance must be taken into consideration and discussed from the standpoint of the advisability of further elaboration of the result as far as the possibility of bringing about radical changes in technology is concerned. In cases where supplementary research will show that the results open up future prospects of strategic importance, if one may use this expression, a scientific breakthrough and a major offensive on a countrywide scale must be attempted.

The physicists, chemists, and geologists of the Soviet Union must be participants in such a planned and successfully carried out scientific and technical breakthrough into the innermost depth of the atom. Comprehensive plans of this type for carrying out scientific work are being set up under the name of projects in the United States. One may mention a number of major scientific and practical results which have been obtained by following this method of planning and conducting the work.

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What scientific and technical breakthroughs should be made during the Sixth Five-Year Plan on the basis of results obtained in prior scientific research? A number of tasks which come under this description have been drawn up by the Academy of Sciences USSR in cooperation with industrial scientists. The yearly plans of the Academy of Sciences are based on carrying out work of this type. Only a few examples of such problems or tasks can be given in a newspaper article.

During recent years the importance of semiconductors has increased at a high rate. Such semiconductors as silicon and germanium of the highest purity have radically changed radiotechnology and some other fields of electrical engineering by making it possible to replace the relatively large tubes with small crystals of semiconductors which serve as rectifiers and amplifiers. The development of the theory of semiconductors and a number of outstanding discoveries in this field are to a major extent achievements which must be placed to the credit of Soviet physicists. USSR physicists have shown that semiconductors can be used for the direct transformation (without any mechanism consisting of moving parts) of heat energy and light into electrical energy with degrees of efficiency which are acceptable for many practical applications. The efficiency at present reaches 10% and theoretical considerations indicate that it can be raised still further. The new possibilities which have been opened present us with technological tasks of immense significance in connection with the creation of a new branch of engineering by means of which waste heat, and possibly also other forms of heat, as well as energy supplied by the sun, will be transformed directly into electrical energy.

It is not out of the question that the new source of power will compete with nuclear power and that the deserts of the hot climatic region will become one of the major sources of power production.

The major tasks which have been imposed on the Institute of Semiconductors, Academy of Sciences USSR, can be solved only when the work is carried out in cooperation with other institutes active in the fields of physics and chemistry and with design bureaus and industrial plants.

To give another example, the scientists of the USSR have advanced to the forefront as far as techniques of calculation are concerned. The large electronic calculating machine BESM, which carries out on the average 7-8,000 arithmetic operations per second, is apparently one of the most rapid in Europe. The calculations which have already been carried out by this machine during a short period of time correspond to the work of a staff of calculators who would have received many hundreds of millions of rubles in wages. The BESM machine is already being used in the publication activities of the Academy of Sciences USSR: a number of mathematical tables have been calculated with the aid of this machine and published.

Together with the industry the Academy of Sciences USSR is engages in work on the development of new models of calculating machines which will be still more rapid and cheaper.

The same principle can be applied in the operation of calculating machines which are based on contactless relay circuits rather than electronic circuits. Work on the fundamental relationships pertaining to the operation of such machines is being conducted at the Academy of Sciences USSR. These machines are entirely new as far as their design is concerned and also with respect to some advantages which they offer from the standpoint of applications for specific purposes. One may in particular expect that they will have a memory which is exceptionally great both as far as capacity and length of the time of retention are concerned. This will make it possible to develop information machines of

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unprecedented scope capable of accumulating in their memory huge stores of information and data and then releasing this information and data in any desired combination at a very rapid rate. One may expect that these machines and other machines will be first of all applied in statistics and planning and subsequently to that (and these will be much more complex machines) in scientific work for the rapid selection of information on a desired subject from the inexhaustible store of data contained in scientific publications. Machines of small capacity designed on this basis or on some other basis may be adapted to the control of industrial processes.

Variants of the same type of machines may automatically translate from one language into another on the basis of a scheme which has been set up for this purpose. The first experimental dictionaries and schemes for translation from the English language into the Russian have already been created by the Academy of Sciences USSR. A few days ago a BESM machine which had not been specially adapted for translating work completed the first brief experimental translation and carried out this task in an entirely literate manner. It is true, of course, that the distance between this first trial and the practical utilization of this astonishing achievement of science is as great as the distance between the first airplane and contemporary aircraft. Extensive work must be done before this dream becomes a practically applied reality.

It is clear, however, that as a result of this work we will acquire a powerful means of increasing the productivity of mental work. A new era will begin, the consequences of which one cannot overestimate.

Such machines are an essential supplement to the automatization of production processes which increases the productivity of labor and, step by step, frees human beings of forms of physical labor which are too strenuous, tiring, or harmful. Extensive automatization of production processes is another task which is of exceptional importance and scope. This task is being accomplished by science and technology. It applies to a field where revolutionary changes must be made.

Let us consider still another example. Soviet chemical physics deserves a considerable amount of credit for developing the theory of the so-called chain reactions, particularly of chain reactions with branched chains. Atomic explosions are also branched-chain reactions, except that the atomic nucleus participates in them. Combustion and explosions are ordinary chemical reactions with branched chains. While in an atomic explosion the carriers which propagate the chains are neutrons, radicals fulfill this function in ordinary chemical reactions. By controlling the radicals (i.e., by increasing their number or inhibiting their formation) one may master the course of the reaction. By controlling the chain reaction of the oxidation of hydrocarbon gases derived from the conversion of petroleum, it was possible to direct this reaction into the proper channel for the technical manufacture of formaldehyde, which is one of the principal intermediates used in the chemical industry.

The polymerization reactions which lead to synthetic rubber, polyethylene, and a number of other high-molecular polymers are also chain processes which in this case are distinguished by the peculiarity that the carrier of the chain (i.e., the radical) enters into the composition of the growing molecule. Soviet chemists have demonstrated this with a great degree of clarity. Lately we have developed promising variations of the synthesis from ethylene of various products which have an intermediate molecular weight. This type of synthesis is based on an interrupted polymerization. Crude material for artificial fibers, plasticizers,

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acids, etc., is obtained in this manner. The most extensive utilization of the chemistry of radicals in science and practical work is one of the most important tasks with which we are faced.

This and similar major tasks will be solved on the basis of governmental plans which unify into a single effort the activities of many offices, scientific institutions, and enterprises.

Such plans, which are adapted to a definite stage of the progress of research on certain scientific problems, must include work on the introduction into production of the processes in question and the development of a consumer demand. The newer and more revolutionary a scientific achievement, the more effort will have to be spent on development work. At present many years frequently elapse between the actual discovery and its application in practical work. One cannot reconcile oneself to this situation. Ten years ago at Leningrad a remarkable ultrasound microscope was designed which makes it possible to see objects imbedded in the thickness of a continuous opaque medium, i.e., a metal or a solid rock. Up to now this important new discovery has not been utilized and developed in an adequate manner. We may also mention in this connection another instrument designed at Leningrad, i.e., an ultraviolet microscope which, so to speak, expands the scope of the color vision of human beings and greatly increases the possibility of determining at a glance (on the basis of the ultraviolet color) the nature of substances, tissues, and other objects examined microscopically. The development of this device, which revolutionizes in particular biological research, is being carried out very slowly. One should not forget that the use of this device has been expanded greatly abroad, although it was initially discovered in the USSR.

The borderline fields of science develop more rapidly than the principal fields. Under our eyes geochemistry, chemical physics, and a number of other branches of science have developed. Biochemistry has grown into a field of science which is huge in scope and of the greatest significance. Methods and tools of investigation which have been taken from one science and introduced into another often yield astonishing results. We must therefore pay particular attention to the development of borderline fields of science and to the mutual exchange of research methods between diverse branches of science.

Utilization of new physical methods in biological research is of particular importance for the rapid and productive development of biology. A striking example of this is the application of tracer atoms. Soviet investigators have used this method with a great deal of success in investigations pertaining to processes of metabolism, nutrition, assimilation of carbon dioxide by plants, and synthetic processes taking place in plants. With the use of the same method, fine chemical processes taking place in the central nervous system have been investigated. In addition to extensive studies by the method of conditioned reflexes (according to I. P. Pavlov) the activity of the brain is being investigated with the aid of new electronic methods.

Of the greatest importance also is further penetration into the biological micro-realm, i.e., that of the finest structure of the living organism. The electron microscope makes this penetration possible by degrees of resolution reaching down to the macromolecular structure and opening up and disclosing entirely new aspects of the microscopic structure. A great role in these investigations, in addition to the electron microscope, is played by the ultramicrotome, an instrument which is not yet being produced in the USSR. The ultramicrotomes

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make it possible to prepare slices of any tissue down to 0.01 microns thick as well as those of bacteria and even of virus particles. In this subdivision of biology, just as in other fields in which biophysics, biochemistry, and histochemistry forge ahead, one may expect the most novel discoveries in the contemporary tools available for physical investigation are applied.

The new five-year plan must form a turning point as far as the rate at which the results of scientific research are introduced into technology and into life is concerned.

The most favorable conditions for the development of science have been created in the Soviet Union. The army of scientific workers of the USSR grows in quantity and in the quality of their traning. Any shortcomings in the organization and planning of scientific work must be eliminated persistently and decisively. The scientific workers of the USSR are filled with a strong desire to satisfy to an ever-increasing extent the demands put to them by the state, party, and people and are constantly increasing their active participation in the construction of Communist society. We understand this obligation not only in the sense that problems which have already been set must be solved, but also in the sense that new scientific research must be conducted which will undoubtedly open up new and greater prospects for an extensive development of the productive forces of the country and of the spiritual resources of our society. Every scientific worker beginning with the employee of a plant laboratory and ending with the worker at an academy institute will contribute his part to the advance of science and to the reinforcement of the bond between science and practical developments.

Soviet science in the course of its development widens to an ever-increasing extent its contacts with international science. It regards increasing contacts between scientists of different countries as an important tool by means of which peaceful cooperation between nations is consolidated.

Soviet science will advance to new victories in 1956.

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